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A NOTATION FOR USE IN THE DISCUSSION OF STAR COLORS

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The extension of absolute scales of photographic and photovisual magnitudes to the fainter stars provides a method of determining the colors of objects at present beyond the reach of spectroscopic investigation. For the statistical discussion of such color results it is convenient to adopt, tentatively at least, in place of the conventional color index, a notation similar to that used for spectral classification. Where for the latter we employ the letters B, A, F, G, etc., to represent various spectral types, we choose b, a, f, g, etc., to indicate different classes of color. When a more exact specification is required, a decimal subdivision of the classes may be employed.

Spectral type is determined by the number, character, and distribution of the lines in the spectrum. Color class depends upon the relative intensity of the continuous spectrum background in two different regions whose location varies somewhat with the instrumental equipment and the method of observing. Since both spectral type and color class stand in an intimate relation to the temperature, they are necessarily connected with each other, and when properly defined the color class indicates at once the general character of the spectrum. To secure this advantage, the classes b, a, f, etc., are assumed to represent the colors corresponding to the mean for typical spectra of the classes B, A, F, etc., respectively.

We cannot assume that there is an invariable correspondence between b and B, a and A, f and F, etc., for the observed color C, which specifically is represented by some one of the letters b, a, f, etc., may consist of at least three elements, namely,

$$C = C_S + C_{M,S} + C_\pi \tag{1}$$

The terms in the right member are functions of the quantities represented by the subscript letters. Thus C_S depends on the spectrum S; it is the average color index corresponding to S, a mean result derived from a large number of stars. Three or four determinations are available, for example, those of King, Parkhurst, and Schwarzschild. For the Mount Wilson photometric system we may adopt provisionally

$$C_S = 0.40\, S, \tag{2}$$

in which S has the values -1, 0, $+1$, etc., according as the spectrum is $B0$, $A0$, $F0$, etc. C_S is thus a part of the observed color index C and is expressed in magnitudes.

$C_{M,S}$ depends upon the absolute magnitude M; provisionally, at least, it must also be regarded as a function of the spectrum. Differences in absolute brightness for the same spectral type doubtless are accompanied by differences in stellar dimensions, and hence also by variations in the extent of the stellar atmosphere. These may produce modifications of intensity in the continuous spectrum, which possibly are also dependent upon the spectral type.

The last term C_π, provides for a scattering of light in its passage through space. It is a function of the parallax π or the distance Δ, but is independent of the spectrum. It may be expressed in the form adopted by Kapteyn, namely,

$$C_\pi = d\Delta \tag{3}$$

in which $\Delta = 0''.1/\pi$, while d is the change in the color index produced by an increase of one unit in the distance.

Finally, for the more precise definition of the color symbols it is convenient to suppose that the observed color index C is connected with the color classes b, a, f, etc., by the relation

$$C = 0.40s \tag{4}$$

or

$$s = 2.5C, \tag{5}$$

in which s is specifically denoted by $b0$, $a0$, $f0$, etc., when its numerical values are -1, 0, $+1$, etc., respectively. The relation is analogous to that connecting the average color index with spectral type.

Equation (1) can therefore be written in the form

$$s = 2.5\,C = S + 2.5\,C_{M,S} + 2.5\,d\Delta, \tag{6}$$

from which it appears that s differs from the spectrum S only in so far as the object in question deviates in luminosity and distance from the mean conditions underlying the color index and spectrum relation defined by equation (2). The color symbols b, a, f, etc. are thus intimately related to the spectrum symbols B, A, F, etc., and it will often be convenient to refer to them as *hypothetical spectra.*

As a matter of further notation, we may define the difference $C - C_S = C_E$ as the *color excess,* that is, the excess of the observed color over the mean color index corresponding to the spectrum S.
We have

$$C_E = 0.4\,(s - S) = C_{M,S} + d\Delta. \tag{7}$$

The color excess therefore represents the combined effect of the luminosity and distance terms, and is useful in investigations undertaken for the determination of the reality and magnitude of the phenomena giving rise to these terms.